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IS : 2711 - 1979
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Indian Standard
SPECIFICATION FOR DIRECT READING *p*H METERS
(Second Revision)

Second Reprint FEBRUARY 1997

UDC 543.257.1.083.1

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Gr 3

March 1980

Indian Standard
SPECIFICATION FOR DIRECT READING *p*H METERS
(Second Revision)

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Indian Standard

SPECIFICATION FOR DIRECT READING *p*H METERS

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 20 November 1979, after the draft finalized by the Industrial Processes Measurement and Control Sectional Committee had been approved by the Executive Committee.

0.2 This standard was first published in 1964 when BS 3422 : 1961 Laboratory *p*H deflection meters was adopted as an Indian Standard for the purpose of ISI Certification Marking Scheme. The first revision in 1966 followed BS 3422 : 1961 to a large extent.

0.3 Current varieties of laboratory *p*H meters include the automatic (servodriven) potentiometer type, the moving coil type and the more recent digital display type. The manually operated null or potentiometric type is now becoming obsolete. The present revision is to give requirements for all laboratory *p*H meters, regardless of type.

0.4 The *p*H value or hydrogen ion concentration is a measure of the acidity or alkalinity (basicity) of a solution. It is expressed as follows:

$$pH = \log \frac{1}{(H+)}$$

where (H+) is the hydrogen ion concentration of solution in moles per litre.

A neutral solution has a *p*H value of 7, an acid solution has a *p*H value less than 7, and a basic solution has a *p*H value greater than 7. A change of one *p*H unit corresponds to a 10-fold change of hydrogen ion concentration of the solution.

The electric potential developed between two suitable electrodes immersed in a given solution has a direct relation to the hydrogen ion concentration of the solution. This property is made use of in measuring the *p*H value of the solution.

0.5 This specification applies to direct reading *p*H meters, both mains and battery-operated instruments. Only essential aspects of performance of *p*H meters are covered in this standard. Interchangeability of accessories of *p*H meters has also been taken into consideration.

0.6 Compliance tests and methods of measurement on direct reading *p*H meters are covered separately in IS : 4309-1979[*].

0.7 In the preparation of this second revision, considerable assistance has been derived from draft revision of BS 3145 Laboratory *p*H meters, issued by the British Standards Institution.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960[†]. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers requirements for *p*H meters for laboratory use regardless of type.

1.1.1 This standard does not cover instruments designed for use in automatic recording or for control of *p*H value.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Laboratory *p*H Meter — Instrument designed for general laboratory use by means of which either the *p*H of a solution, or the potential difference between electrodes immersed in a solution, is indicated.

2.2 Range — Interval in *p*H or millivolts between the lower (minimum value of *p*H or millivolts) and upper (maximum value of *p*H or millivolts) range limits.

2.3 Moving Index Instrument — Indicating instrument in which the index is a pointer moving over a scale.

. .4 Scale Interval — Value of the measured quantity corresponding to a scale division.

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[*] Methods of measurement on direct reading *p*H meters (*first revision*).

[†] Rules for rounding off numerical values (*revised*).

2.5 Scale Division — Interval between the centres of two adjacent scale marks on an instrument with a scale or chart.

2.6 Scale Spacing — Linear or curvilinear length, measured along the scale base, between the axes of two consecutive minor scale marks.

2.7 Digital *p*H Meter — *p*H meter in which the measured value is displayed as a group of digits.

2.8 Representation Unit — Minimum increment between two successive output states of a digital *p*H meter.

2.9 Set Buffer Adjustment — Control for adjusting the *p*H meter to indicate the value of the *p*H of standardizing solution.

2.10 Slope Factor — Temperature dependent proportionality factor between potential and *p*H.

NOTE — This factor is dependent on temperature and also on non-Nernstian response.

2.11 Slope Factor Adjustment — Manual control by which readings on the *p*H scale can be corrected for variations of temperature.

2.12 Slope Factor Adjustment — Device, similar in design to that given in **2.11**, used in conjunction with two-point standardization procedures to correct for non-Nernstian response of the electrode system.

2.13 Isopotential Control — Control which determines the point on the *p*H scale where the correcting effect of the temperature compensation device is zero. This additional temperature compensating device permits a correction to be made for standard potential changes when:

a) test and standard buffer differ in temperature, or
b) glass and reference electrodes differ in temperature.

2.14 Zero Point — Value of the *p*H of a solution, which, for a given glass electrode in combination with a stated outer reference electrode system, gives zero potential difference from the system.

2.15 Error (of Indication) — Difference ($v_i - v_0$) between the value indicated by the *p*H meter (v_i) and the conventional true value of the measured quantity (v_0).

2.16 Calibration — Operation of determining the errors (of indication) of a *p*H meter.

2.17 Intrinsic Error — Error of *p*H meter under reference conditions.

2.18 Input Current — Current flowing through the glass electrode and reference electrode cell under specified conditions of input voltage.

2.19 (Overall) Instrument Error — Whole error of a *p*H meter under specified conditions of use.

2.20 Influence Quantity — Any quantity, generally external to the *p*H meter, which may effect the performance of the *p*H meter.

3. MEASURED QUANTITY

3.1 The value of the measured quantity may be presented by:

a) a moving index instrument,

b) a digital instrument,

c) a recording instrument, and

d) a binary coded decimal (b. c. d.) output.

3.2 The principal form of presentation is usually (a) or (b) with (c) and/or (d) as optional accessories. The manufacturer shall state in the literature provided with the *p*H meter which is the principal method of presentation adopted and which optional methods are available together with a description of these, for example, parallel b.c.d., isolated potentiometric recorder output, etc.

NOTE — Requirement for the recorder does not form part of this standard.

4. CLASSIFICATION

4.1 The instrument shall be classified into the following according to their accuracy:

Class	*Accuracy*
A	0·1 *p*H
B	0·05 *p*H
C	0·02 *p*H
D	0·01 *p*H
E	0·001 *p*H

5. SCALE

5.1 The instrument shall be calibrated in *p*H units and in millivolts, the latter being optional.

5.2 The instrument should cover at least 10 *p*H units in the range of 0-14 *p*H.

NOTE — The other ranges may be agreed to between the manufacturers and the user.

5.3 For instruments with scales or charts, the scale spacing (in millimetres) and the scale interval on both *p*H and mV scales and on any multi-range scales shall be stated in the literature provided with the *p*H meter.

5.4 For moving index instruments, the scales shall be divided and marked in compliance with the recommendations laid down. The index (knife edge) and (minor) scale mark thickness shall be one-tenth of the scale division in order to facilitate interpolation by eye into fifths.

NOTE — Recommendations are under consideration at present.

5.5 For digital instruments, the height of the numerical display in millimetres shall be stated in the literature provided with the *p*H meter.

5.6 In a multi-range instrument, the range in use shall be clearly indicated on the front panel.

6. ERRORS OF INDICATION

6.1 The intrinsic error of indication arising from graduation and non-linearity at any point shall not exceed on any range the accuracy specified (*see* **4.1**).

6.2 The overall instrument error shall not exceed, at any point on any range, twice the intrinsic error on that range.

6.3 On multi-range instruments, the manufacturer shall state in the literature provided with the *p*H meter whether the electrode system should be separately standardized on each *p*H scale. If switching between scales without restandardizing is intended, then the error of indication arising from scale incompatibility shall not exceed the average accuracy of the *p*H meter when switching between the principal scale and expanded scale.

6.4 The methods of tests for errors of indication and compliance to **5** are specified in **5.1** to **5.3** of IS : 4309-1979*.

7. INPUT CURRENT

7.1 The input current at zero voltage shall not cause an error of indication of more than 0·15 *p*H (or 10 pA) irrespective of the class of *p*H meter when a 1 GΩ source resistor is used.

NOTE — A glass electrode with 1 GΩ resistance at 27°C would have a resistance of about 10 GΩ at 0°C, and this would result in an error of indication if the electrode is calibrated at 25°C and used at 0°C. However, an electrode with a resistance lower than 1 GΩ at 27°C would normally be selected for use at lower temperatures.

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*Methods of measurement on direct reading *p*H meters (*first revision*).

7.2 The change in input current over the scale range of the *p*H meter shall not lead to an indication error greater than the intrinsic accuracy for the respective class of *p*H meter when a 1 GΩ resistor is used at 27°C.

7.3 Methods of tests for input current and compliance with **7** are specified in **7** of IS : 4309-1979*.

8. STABILITY

8.1 The manufacturer shall state in the literature provided with the *p*H meter the recommended values and ranges of influence quantities for example, ambient temperature, relative humidity, etc, except those given in **8.2** to **8.5**.

8.2 The *p*H reading shall not change by more than the intrinsic accuracy specified for the respective *p*H meter during 1 h after warm up period at mains voltage and frequency. The mains voltage shall be within ± 2 percent of the rated value.

8.3 For mains supply instruments the manufacturer shall state in literature provided with the *p*H meter the maximum permitted mains supply voltage variation. This shall be within − 10 to + 6 percent and shall produce a variation of not more than the intrinsic error of the *p*H meter either in *p*H or in mV scale when a 1 GΩ source resistance is used.

8.4 For battery-powered instruments, the manufacturer shall provide instructions for a method of determining, when, an error of indication more than the intrinsic error of the instrument is likely to result from drop in battery voltage.

9. REFERENCE ELECTRODE INPUT

9.1 The reference electrode socket shall be designed so as to make good electrical contact with the reference electrode plug which should preferably be one having the 4 mm diameter shaft commonly in use, but a 2 or 3 mm diameter plug is permitted, provided the manufacturer states which has been adopted in the literature provided with the *p*H meter.

9.2 The instrument shall tolerate the reference electrode input being earthed, floating or ± 2 V from earth, and reference electrode resistances up to 100 kΩ. Under all these conditions, additional errors of indication shall be less than the intrinsic error of the instrument.

NOTE — Compliance with this requirement can be tested by connecting a 2 V battery between instrument and earth, and then reversing the connection, and using a 100 kΩ resistor in series with the reference electrode.

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*Methods of measurement on direct reading *p*H meters (*first revision*).

10. TEMPERATURE COMPENSATING DEVICES

10.1 The instrument shall be provided with a manually operated or automatic device by means of which readings on the *p*H scale can be corrected for changes in the solution temperature from 27°C (slope factor compensation). The range of any such device shall be stated in the literature provided with the *p*H meter.

10.2 There shall be a scale mark at 27°C. The scale interval of the device shall be at least 2°C for class A to class D *p*H meters and for class E *p*H meters it shall be 200 times the numerical value of the intrinsic accuracy. The manual temperature compensator shall not lead to an error of indication of more than twice the overall accuracy of the class A to D *p*H meters and 10 times the overall accuracy for class E *p*H meters at 27°C.

NOTE — An error of 1°C in setting a manual slope factor compensating device at 27°C will lead to an error of nearly 0·010 in the *p*H of a test solution 3 *p*H units removed from the standardizing buffer value when both test and standardizing solutions are at 27°C. If the test and standardizing solution differ in temperature, the error is a function of the difference between the isopotential *p*H and that of the test buffer. Thus if this difference is 3 *p*H, an error of 0·01 *p*H can be produced by a difference in temperature of 1°C. It should therefore be possible to set the manual temperature compensator more accurately than this. For a 0·01 *p*H meter 10·2 requires the compensator to be scaled every 2°C, which should permit interpolation to 0·4°C. The tolerance in linearity of the variable resistors used for compensators is, however, usually not better than ± 1 percent, which corresponds to ± 1°C in a compensator having 0°C to 100°C range.

10.3 An automatic temperature compensating device shall not lead to an error of more than twice the overall accuracy for class A to D *p*H meters and ten times the overall accuracy for class E *p*H meters throughout the temperature range.

11. SET BUFFER ADJUSTMENT

11.1 The range of the set buffer control shall be such as to permit the use of glass electrodes with zero point values to be specified by the manufacturer of the *p*H meter.

12. SLOPE FACTOR ADJUSTMENT

12.1 Slope factor adjustment control (if fitted) shall be scaled in percentage of the theoretical slope factor. It shall be possible to set this control to the value (100 percent) corresponding to the theoretical slope factor without incurring an error of indication of more than the intrinsic accuracy of the class of *p*H meters.

13. ELECTRICAL SAFETY AND EARTHING

13.1 The instrument shall be suitably earthed, the supply leads and other cords suitably colour coded for easy identification.

13.2 The case and controls shall be screened so as to shield the instrument satisfactorily from neighbouring electric field, electrostatic charges induced on the body of the operator, etc.

14. MARKING

14.1 The instrument shall be clearly and indelibly marked with the following:

a) Trade-mark of the manufacturer,
b) Type and serial number, and
c) Power supply requirements.

14.2 BIS Certification Marking

The product may also be marked with Standard Mark.

14.2.1 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

15. INSTRUCTION MANUAL

15.1 A copy of the instruction manual shall be furnished with each instrument.

15.2 The instruction manual for *p*H meter shall contain the following information:

a) Power supply requirements,
b) Instructions for use,
c) Precautions to be taken with the instrument,
d) Dimensions and weight, and
e) Name of the manufacturer.

15.2.1 It shall contain a complete list of parts, spares and accessories supplied or recommended for use along with the circuit diagram, operating, servicing and maintenance instructions.

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Printed at New India Printing Press, Khurja, India

AMENDMENT NO. 1 FEBRUARY 1983

TO

IS:2711-1979 SPECIFICATION FOR DIRECT READING *p*H METERS

(Second Revision)

Alteration

(*Page 7, clause 5.4*) - Substitute the following for the existing clause:

'5.4 For moving index instruments, the scales shall be devided and marked with the major scale marks in series of one. Each dimension on the full scale shall represent a minimum of 0.1 *p*H.'

(ETDC 67)

Reprography Unit, ISI, New Delhi, India